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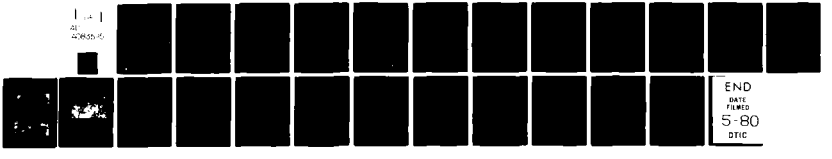

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MR 80-1 (I)

Ecological Evaluation of a Beach Nourishment Project at Hallandale (Broward County), Florida

Volume I

Evaluation of Fish Populations Adjacent to Borrow Areas of Beach Nourishment Project, Hallandale (Broward County), Florida

by
Walter R. Courtenay, Jr.,
Ben C. Hartig, and Gerard R. Loisel

MISCELLANEOUS REPORT NO. 80-1 (I)
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A study of the fish populations within the surf zone and over the first and second reefs off Hallandale (Broward County), Florida, was conducted, 7 years following dredging for a beach restoration project. This study utilized an observational and recording technique adapted from Jones and Thompson (1978). The data were compared with those of an earlier study conducted in 1971-72.

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-In the 1971-72 study, conducted during and subsequent to dredging activities, 42 species of fishes belonging to 24 families were found. The present study revealed the presence of 114 species of fishes belonging to 36 families. The dusky jawfish *(Opistognathus whitehursti)*, common along the first reef platform in 1971-72, was found to be absent. The absence of this fish is attributed to an alteration of the substrate on the first reef by incursion of fine sediments. Damage to the second reef observed during 1971-72 was not evident during this study.

PREFACE

This report (Vol. I) is published to provide coastal engineers the first comprehensive study of the impact of beach nourishment and offshore borrowing on nearshore and coral reef fish populations. In Volume II, benthic communities adjacent a restored beach are analyzed and compared to similar nearby communities. Both studies were conducted at Hallandale (Broward County), Florida. The work was carried out under the coastal ecology research program at the U.S. Army Coastal Engineering Research Center (CERC).

This report was prepared by Dr. W.R. Courtenay, Jr., Professor of Zoology, B.C. Hartig, a candidate for the Master of Science degree, and G.R. Loisel who recently completed the Master of Science in Teaching degree, Florida Atlantic University, Boca Raton, Florida, under CERC Contract No. DACW72-78-M-0769.

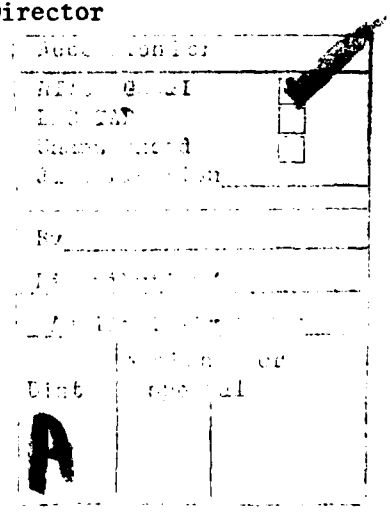
The authors express their appreciation to A. Abel and W.N. Watkins for photographic support, J.L. Lane for typing support, and J. Marcusky and T. McKay for the use of boats. Special thanks are due L.M. Stanaland for her assistance on this study from September to December 1978.

R.M. Yancey was the contract monitor, under the general supervision of E.J. Pullen, Chief, Coastal Ecology Branch, CERC.

Comments on this publication are invited.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

TED E. BISHOP
Colonel, Corps of Engineers
Commander and Director



CONTENTS

FIGURES

CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	by	To obtain
inches	25.4	millimeters
	2.54	centimeters
square inches	6.452	square centimeters
cubic inches	16.39	cubic centimeters
feet	30.48	centimeters
	0.3048	meters
square feet	0.0929	square meters
cubic feet	0.0283	cubic meters
yards	0.9144	meters
square yards	0.836	square meters
cubic yards	0.7646	cubic meters
miles	1.6093	kilometers
square miles	259.0	hectares
knots	1.852	kilometers per hour
acres	0.4047	hectares
foot-pounds	1.3558	newton meters
millibars	1.0197×10^{-3}	kilograms per square centimeter
ounces	28.35	grams
pounds	453.6	grams
	0.4536	kilograms
ton, long	1.0160	metric tons
ton, short	0.9072	metric tons
degrees (angle)	0.01745	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins[1]

[1]To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula: $C = (5/9)(F - 32)$.

To obtain Kelvin (K) readings, use formula: $K = (5/9)(F - 32) + 273.15$.

EVALUATION OF FISH POPULATIONS ADJACENT TO BORROW AREAS OF BEACH NOURISHMENT PROJECT, HALLANDALE (BROWARD COUNTY), FLORIDA

by

Walter B. Courtenay, Jr.
Ben C. Hartig
and
Gerard R. Loisel

I. INTRODUCTION

For several years, a significant number of beaches along the southeastern coast of Florida have undergone severe erosion (U.S. Army Engineer District, Jacksonville, 1965). A major beach nourishment and restoration program in this area, the Broward County Beach Erosion Control Project, was authorized by the Rivers and Harbors Act of 27 October 1965. One segment of the project, Hallandale in southeastern Broward County, was nourished with offshore sand between 21 July and 21 September 1971. Courtenay, et al. (1973, 1974) noted damage by dredging activities off Hallandale to an extensive area of offshore patch reefs extending out to and including the offshore edge of the second reef platform. Damage was reported as being most evident within a radius of 400 to 800 meters of the borrow area; however, a reevaluation of data indicates the area of damage was between 130 and 220 meters of the nearest borrow area, encompassing an area of approximately 2.5 square kilometers. The reef damage was attributed to rehandling of fill material, to the type of dredging equipment used, and to a piece of dredging equipment that overturned in a storm (Courtenay, et al., 1973, 1974). Algae and permanently attached bivalve mollusks were killed by burial. Soft corals were not affected but hard corals showed substantial damage. Motile species such as lobsters, crabs, shrimps, and fishes apparently left the area during dredging but began to reappear within 4 months following cessation of dredging activities.

This study assesses the status of fish populations within the borrow areas, in areas of reef damage, and adjacent areas within approximately 0.5 kilometer from the borrow areas off Hallandale, 7 years after dredging. The data were compared with those obtained during a previous study (Courtenay, et al., 1974).

Although the assessment techniques used in the 1971-72 study differ from those used during this project, valid comparisons were made. The 1971-72 study was conducted using the ichthyocide

rotenone as the primary sampling technique. While rotenone will kill most fishes and many of the more cryptic or secretive species, it is not a quantitative sampling method; several larger fishes, especially sharks, rays, and some pelagic and benthic bony fishes will actively avoid rotenone.

The present study utilized an observational and recording technique adapted from Jones and Thompson (1978). The need for replicate series sampling precluded the use of ichthyocides. Jones and Thompson compared results of their technique in reefs at John Pennekamp State Park off Key Largo (Monroe County), Florida with Starck's (1968) study using rotenone at Alligator Reef (Monroe County), Florida. Their study showed that the observational and recording technique of eight replicates per station accounted for 93.5 percent of the more commonly occurring suprabenthic (above-bottom) fishes on Florida reefs. However, the technique did not account for the majority of cryptic species.

II. MATERIALS, METHODS, AND PROCEDURES

The assessment of fish populations adjacent to borrow areas off Hallandale began in September 1978 and was completed in March 1979. Fishes were observed and recorded by a technique adapted from Jones and Thompson (1978). The procedure required a pair of observers, equipped with scuba, a watch, and an underwater writing slate. The divers were allowed 50 minutes to locate and record as many fish species as possible within the confines of the study area. There were no specific transects.

The 50-minute diving time was subdivided into five 10-minute periods. Species were recorded only once and tallied in the specific 10-minute interval in which they were first seen. Fishes occurring within the first 10-minute interval were given a score of five, those within the second interval a four, etc., to the fifth interval for a score of one. The assumption is that the species occurring within the earliest time intervals are likely to be the most abundant.

Each diver's species tally at the end of the 50-minute dive was considered as one run. There were 10 runs or replicates made in the surf zone, 12 runs on the first reef, and 12 runs on the second reef. The number of runs was considered sufficient in a particular area when no new species were observed in two consecutive dives.

The scores for each species from each run were summed and averaged. The values ranged from 0.08 to 5.0. These figures were then plotted on a graph against their frequency of occurrence. Cutoff points were then assigned five abundance ratings: species with values ranging from 0.08 to 0.42 were considered rare (R); 0.50 to 1.58, occasional (O); 1.67 to 2.75, frequent (F); and 2.83 to 3.92, common (C). A species with a value ranging from 4.0 to 5.0 was given an abundant (A) rating. These ratings were then compared with those of Courtenay, et al. (1974).

Lists of fish species observed are given in the Appendix. They are cited by families in a sequence after Bailey, et al. (1970). Starck's (1968) method of denoting primary reef species (P) and secondary reef species (S) has been followed. *Primary reef species* are species characteristically associated with the reefs. *Secondary reef species* are species which, though normal residents of reef areas, are more ubiqitous in their selection and utilization of habitats.

Seine and hand nets, underwater photography, and the anesthetic quinaldine were used to aid in the collection and identification of some species.

III. DESCRIPTION OF THE STUDY AREA

Hallandale, located in southeastern Broward County (Fig. 1), is bordered by a single rock groin to the north and a series of apartment or condominium buildings at the southern limit. Off Hallandale, three areas or zones of study were used to investigate the long-term effects of beach nourishment on the fishes of the area: the surf zone, the first reef, and the outer or second reef (Fig. 2).

The surf zone is an area of sandy bottom, extending from the beach to approximately 10 meters offshore. Beyond the surf zone is an area of sandy bottom that extends an additional 40 meters out to the inshore edge of the first reef. The substrate throughout this area appears to consist of dredged fill subsequently eroded from the beach by wave action. The water in this area is usually milk-colored due to wave action on fine silts. Fishes inhabiting the surf zone are generally small and characteristic of sandy areas. The water depth in the surf zone reaches 1 meter.

The first reef has a predominantly low profile, with its inshore margin located approximately 50 meters and its offshore edge approximately 100 meters from the beach. The water depth is 5 to 7 meters. The northern part is mostly flat and barren, of patchy rock with few live corals present. Few fishes are seen on this section of the reef. Southward along the reef edge, the height increases with a prominent ledge approximately 1 meter high originating near the southern boundary of the study area (Fig. 3). This higher relief part of the reef is characterized by much more cover and an increase in live corals and diversity of the fishes present. The water over the first reef is also usually turbid, but less so than in the surf zone (Marsh, et al., in preparation, 1980).

Beyond the first reef is an expanse of sandy bottom that extends for approximately 60 meters to the inshore edge of the second reef. The second reef is approximately 500 meters wide with an 8- to 13-meter water depth. The water is usually clearer than at the first reef. The second reef has a higher profile, with an extensive outside ledge that reaches 3 meters in some places (Fig. 4). This reef has a profusion of live, soft and hard corals and a large network of potholes and small ledges which afford more cover to the

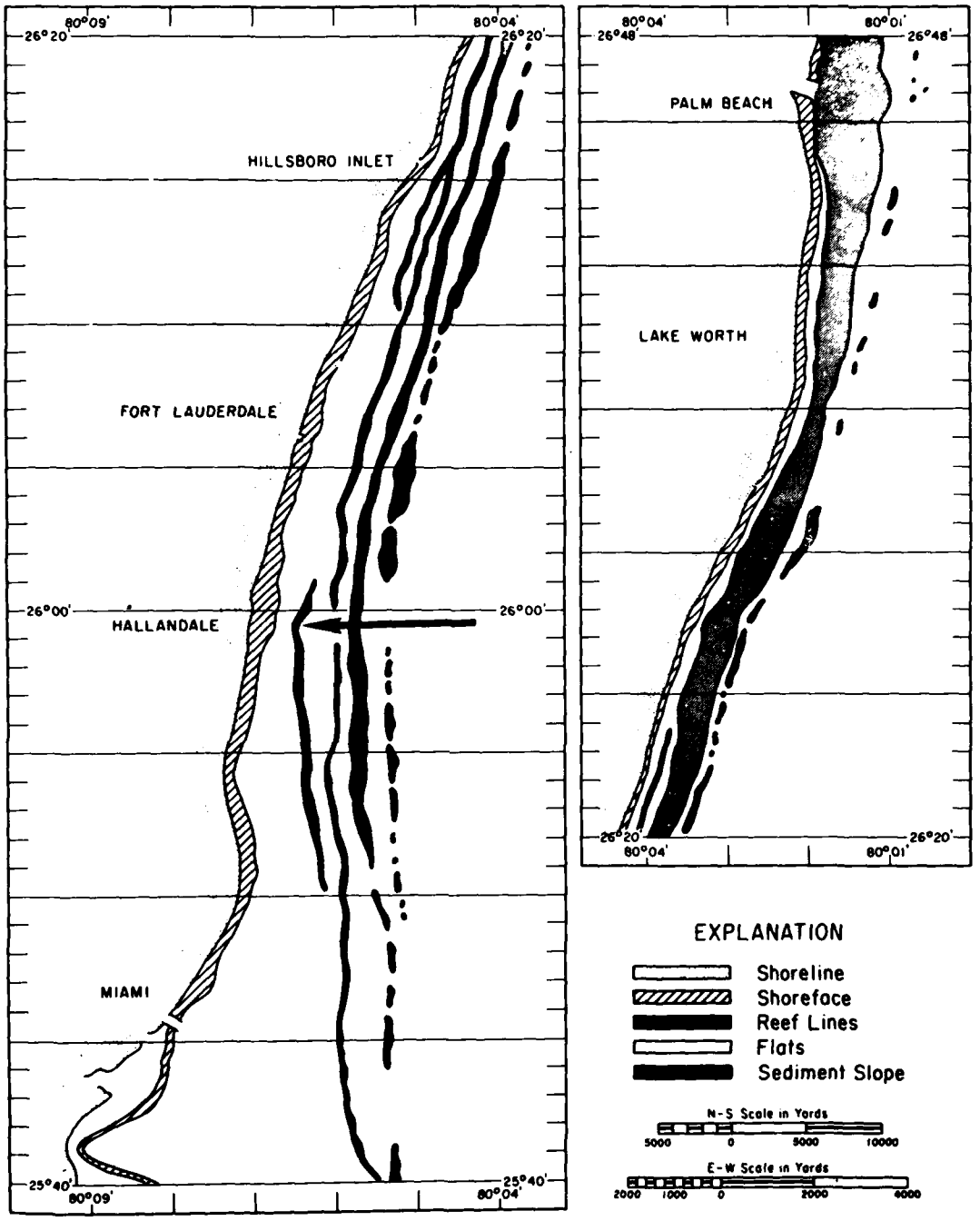


Figure 1. Location of study area and plan of southeastern Florida shelf morphology (after Duane and Meisburger, 1969).

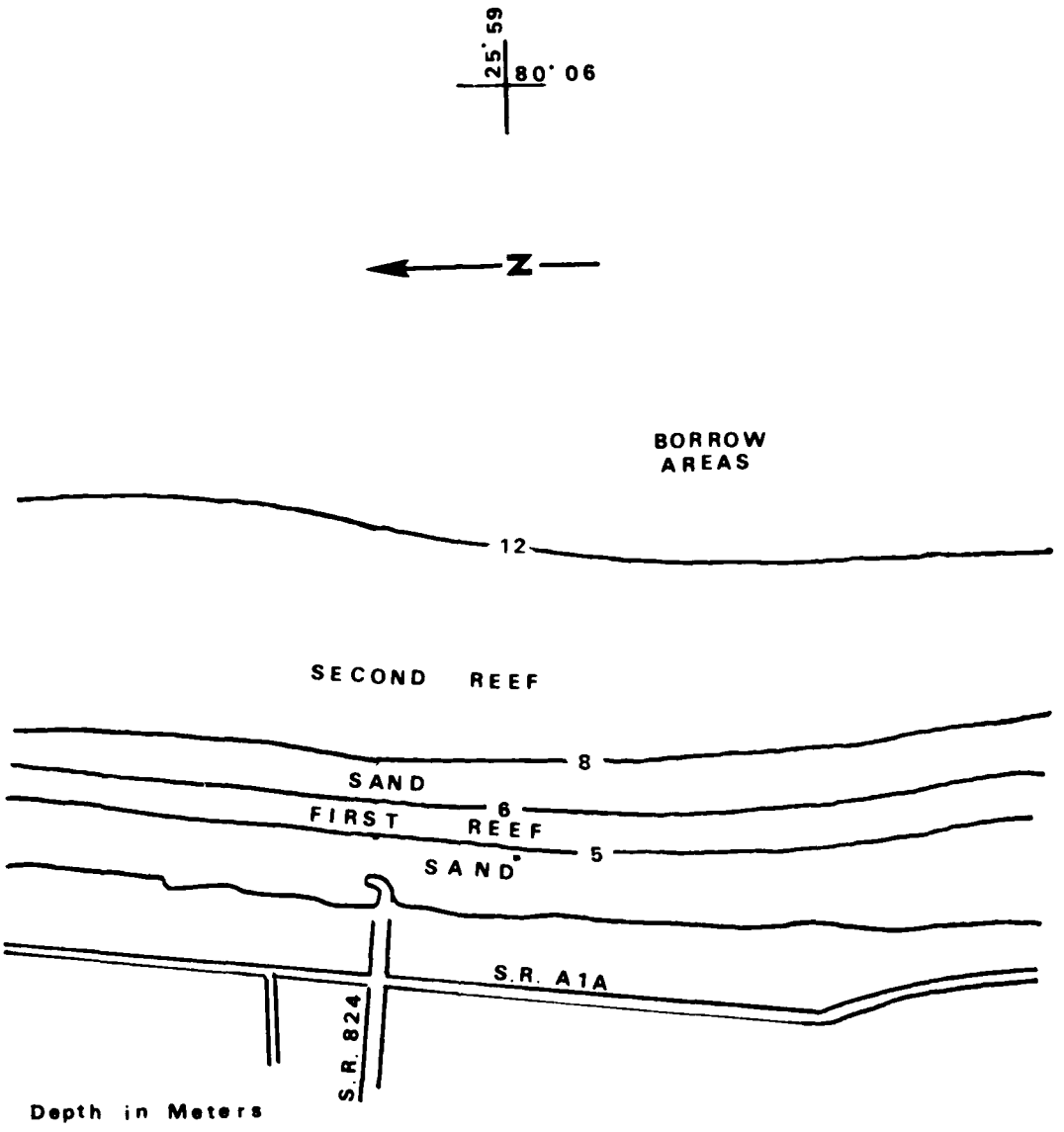


Figure 2. Shelf morphology off Hallandale.

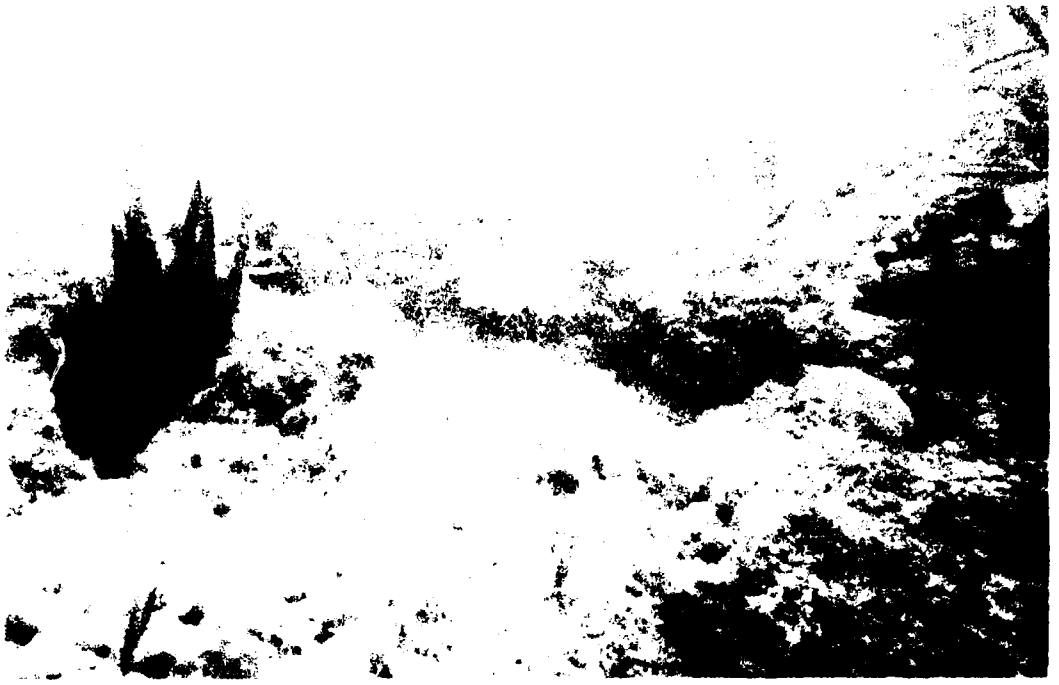


Figure 3. Higher profile area of first reef platform.

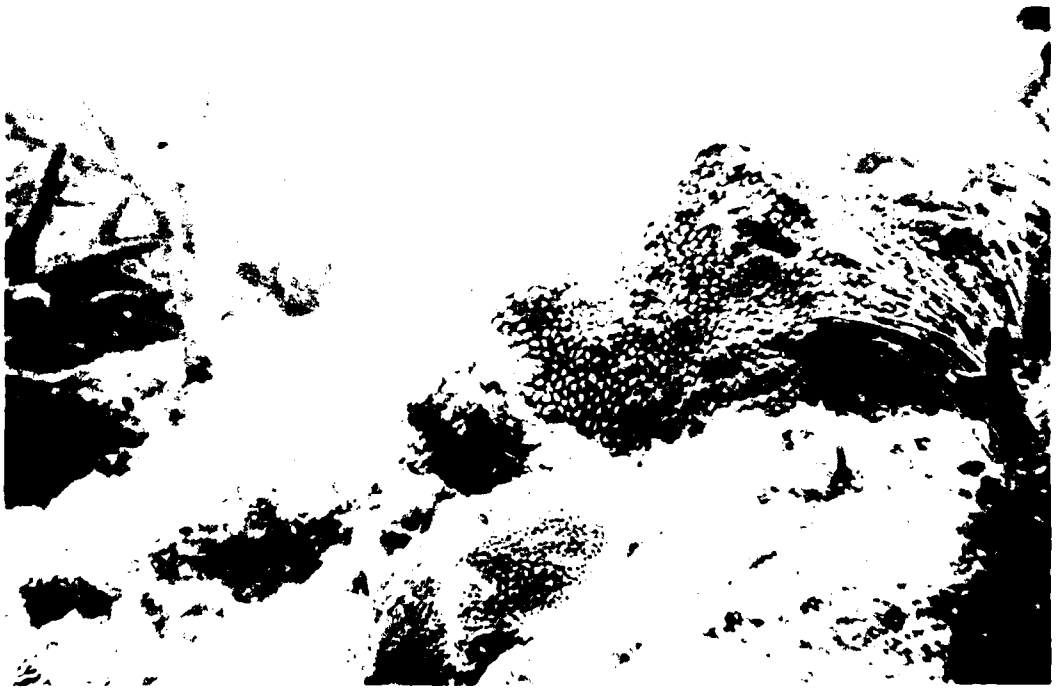


Figure 4. Outside ledge area of second reef platform.

fishes inhabiting this area (Fig. 5). The fish fauna of the second reef consists of larger and more numerous fishes than on the first reef. The "typical" reef fishes, such as angelfishes (*Chaetodontidae*), butterflyfishes (*Chaetodontidae*) and damselfishes (*Pomacentridae*), are better represented in both species and numbers. Some of the larger and faster fishes, such as cero mackerel (*Scomberomorus regalis*) and blue runner (*Caranx crysos*), were observed on the second reef and not on the first reef.

Figure 5. Top of second reef platform.

IV. RESULTS

Courtenay, et al. (1974) noted considerable turbidity nearshore off the nourished beach. This condition still exists with underwater visibility rarely exceeding 2 meters. The bottom is strewn with rocks and fine sand and silt. Much of this material covers the first reef. Underwater visibility over the first reef was generally between 3 to 4 meters but increased to 6 to 8 meters over the second reef.

A total of 114 species of fishes belonging to 36 families was observed in the study area (App.). Nine species belonging to seven families were found in the surf zone. The permit (*Trachinotus falcatus*) was the most abundant species in this area. The spotfin mojarra (*Eucinostomus argenteus*) and the sand drum (*Umbrina coroides*) were also common. Lack of cover, wave action, and limited

food are among the factors limiting the number of fish species occupying the surf zone.

On the first reef 67 species representing 26 families of fishes (see App.) were observed. Courtenay, et al. (1974) suggested that the low profile of this reef area provides limited cover and, therefore, restricts the number of species of fishes found there. The most abundant species found on this reef in 1978-79 was the slippery dick (*Halichoeres bivittatus*). Tomtate (*Haemulon aurolineatum*), high-hat (*Equetus acuminatus*), cocoa damselfish (*Pomacentrus variabilis*), bluehead (*Thalassoma bifasciatum*), redtail parrotfish (*Sparisoma chrysopterum*), and doctorfish (*Acanthurus chirurgus*) were also abundant. Sizable aggregations of grunts (*Pomadasyidae*), angelfishes, and parrotfishes (*Scaridae*) occurred at specific locations on the first reef. Damselfishes were also well represented.

Courtenay, et al. (1974) recorded the dusky jawfish (*Opistognathus whitehursti*), a burrowing species, as common along the platform of the first reef. No specimens of this fish were observed there in 1978-79. The absence of this species is probably caused by the substrate having been altered by incursion of finer materials, possibly eroded beach fill materials.

Eighty-nine species belonging to 30 families of fishes were observed on the second reef (App.). The most abundant species was the bluehead. Bicolor damselfish (*Pomacentrus partitus*), slippery dicks, and doctorfish were also abundant. Gobies (Gobiidae), parrotfishes, angelfishes, grunts, and sea basses (Serranidae) were also well represented on this reef. Certain species such as the longspine squirrelfish (*Holocentrus rufus*), tobaccofish (*Serranus tabacarius*), harlequin bass (*Serranus tigrinus*), and blue chromis (*Chromis cyaneus*) were present on the seaward side of the second reef but absent on the inshore side.

The blue goby (*Ioglossus calliurus*), a burrowing fish, was seen frequently in the sandy area adjacent to the second reef. Another burrowing species, the yellowhead jawfish (*Opistognathus aurifrons*), however, was rare.

Other fishes observed over the sandy areas adjacent to the second reef include the sand perch (*Diplectrum formosum*), tobaccofish, yellowfin mojarra (*Gerres cinereus*), and bridled goby (*Coryphopterus glaucofraenum*).

V. DISCUSSION AND CONCLUSIONS

Courtenay, et al. (1974) list 42 species belonging to 24 families of fishes as having been collected in the area of the Hallandale beach restoration project; they emphasize, however, that sampling in the study area was incomplete. The present study revealed the presence of 114 species of fishes belonging to 36 families. In the 1971-72 survey, fish collections were made using the ichthyocide rotenone. The present study used underwater observations primarily and the anesthetic quinaldine as an incidental collecting method.

The results of the present study demonstrate that although the fish fauna in the Hallandale area is rich, the dusky jawfish may have been affected adversely by dredging activities and later by beach erosion. The first reef appears to have been affected directly by deposition of sediment that further reduced the bottom relief and grain size of the substrate.

The dusky jawfish, a shallow-water burrowing species, has been used as an indicator species in studies of the effects of beach nourishment projects (Courtenay, et al., 1974). Thompson (1974) showed that this species typically burrows in sand areas at the edge of a vertical surface, usually of rock or dead coral, and never on a level surface. There these fishes excavate permanent burrows on the reef platform which they abandon only under conditions of considerable stress. In the previous study (Courtenay, et al., 1974), dusky jawfish were common on the first reef. This species was not observed during this study. The absence of this species probably can be attributed to an alteration of the substrate and habitat possibly due to deposition of fill materials. The fine-grained sediment is unstable for burrowing. Deposition on the first reef also reduced the available vertical surfaces. During 1971-72, the first reef received only negligible damage from erosion of the filled beach. The present study indicates that the movement of fines covered the lower profile portions of the first reef.

Certain species such as the belted cardinalfish (*Apogon townsendi*) and the roughhead blenny (*Acanthemblemaria aspera*), collected at Hallandale in 1971-72 (Courtenay, et al., 1974), were not observed in this study. Courtenay, et al. (1974) predicted a decline of fishes and other marine animals on the first reef should further beach erosion occur.

The second reef, located farther offshore, showed no effects of the 1971 beach restoration project or erosion and incursion of sediment. Previous damage (scouring, siltation, etc.) which had occurred as direct effects of dredging was not evident. Corals were abundant and thriving and the reef structure supported a rich fish fauna. Certain fish species such as the bridled goby, the rock beauty (*Holacanthus tricolor*), and the barred hamlet (*Hypoplectrus puella*), absent or listed as rare by Courtenay, et al. (1974), were abundant in this survey. The presence of these fishes in numbers of individuals is attributed to improved conditions following cessation of dredging activities.

In summary, the fish fauna of the second reef off Hallandale shows no damage as a result of the dredging activities of 1971. The first reef, however, has been affected adversely by incursion of sediment.

VI. RECOMMENDATIONS

The recommendations of Courtenay, et al. (1974) are repeated. Before, during, and after beach restoration projects, "surveys should be conducted by both competent biologists and engineering surveyors..."

Duane and Meisburger (1969) recommend sand in the linear second flat for beach fill material based on accessibility, continuity of the deposits, and suitability. They cautioned, however, that these deposits contained a substantial amount of material that could become mechanically degraded in the turbulent littoral zone.

This study indicates that the potential effects of incursion of eroded beach-fill materials on nearshore reefs should be considered in environmental impact studies for future beach restoration and nourishment projects in southeastern Florida.

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APPENDIX

FISHES OF THE HALLANDALE AREA

Common name	Family	Scientific name	Type of reef species[1]	Abundance[2]						
				Surf zone 1979		First reef 1979		Second reef 1979		Relative abundance[3] 1974
				Relative abundance	Index	Relative abundance	Index	Relative abundance	Index	
Carpet Sharks Nurse shark	Orectolobidae	*Ginglymostoma cirratum*	S	--	--	--	--	0	0.58	R
Stingrays Yellow stingray	Dasyatidae	*Urolophus jamaicensis*	S	--	--	0	0.50	0	1.42	0
Morays Spotted moray Purplemouth moray	Muraenidae	*Gymnothorax moringa* *Gymnothorax vicinus*	P P	-- --	-- --	-- 0	-- 1.08	0 --	0.50 --	--
Snake eels Goldspotted eel	Ophichthidae	*Myrichthys oculatus*	S	--	--	--	--	R	0.42	--
Herrings Scaled sardine	Clupeidae	*Harengula pensacolae*	--	0	0.50	--	--	--	--	--
Batfishes Polka-dot batfish	Ogcocephalidae	*Ogcocephalus radiatus*	S			R	0.08	--	--	--
Needlefishes Redfin needlefish	Belonidae	*Strongylura notata*	--	R	0.50	--	--	--	--	--
Squirrelfishes Longspine squirrelfish	Holocentridae	*Holocentrus rufus*	P			--	--	R	0.33	0
Trumpetfishes Trumpetfish	Aulostomidae	*Aulostomus maculatus*	P	--	--	--	--	R	0.17	--
Cornetfishes Bluspoted cornetfish	Fistulariidae	*Fistularia tabacaria*	P	--	--	R	0.33	--	--	--
Pipefishes Pipefish	Syngnathidae	*Syngnathus sp.*	P	--	--	--	--	--	--	0
Snooks Snook	Centropomidae	*Centropomus undecimalis*	S	--	--	--	--	--	--	R
Sea Basses Sand perch Rock hind Red grouper	Serranidae	*Diplectrum formosum* *Epinephelus adscensionis* *Epinephelus morio*	S P P	-- -- --	-- -- --	0 -- 0	0.83 -- 1.08	F R R	2.08 0.08 0.33	-- -- R

See footnotes at end of table.

FISHES OF THE HALLANDALE AREA--Continued

Common name	Family	Scientific name	Type of reef species[1]	Abundance[2]						Relative abundance[3] 1974
				Surf zone 1979		First reef 1979		Second reef 1979		
				Relative abundance	Index	Relative abundance	Index	Relative abundance	Index	
Yellowbelly hamlet		*Hypoplectrus aberrans*	P	--	--	--	--	R	0.25	--
Blue hamlet		*Hypoplectrus gemma*	P	--	--	--	--	C	3.42	--
Barred hamlet		*Hypoplectrus puella*	P	--	--	R	0.17	A	4.25	--
Butter hamlet		*Hypoplectrus unicolor*	P	--	--	--	--	F	2.50	--
Black grouper		*Mycteroperca bonaci*	P	--	--	--	--	--	--	R
Gag		*Mycteroperca microlepis*	P	--	--	R	0.33	O	0.58	--
Scamp		*Mycteroperca phenax*	P	--	--	--	--	O	0.83	--
Graysby		*Petrometopon cruentatum*	P	--	--	--	--	R	0.42	--
Tobaccofish		*Serranus tabacarius*	P	--	--	--	--	O	1.00	--
Harlequin bass		*Serranus tigrinus*	P	--	--	--	--	O	0.50	--
Cardinalfishes	Apogonidae									
Barred cardinalfish		*Apogon binotatus*	P	--	--	--	--	R	0.42	--
Flamefish		*Apogon maculatus*	P	--	--	--	--	O	0.67	C
Twospot cardinalfish		*Apogon pseudomaculatus*	P	--	--	F	2.00	O	1.25	C
Belted cardinalfish		*Apogon townsendi*	P	--	--	--	--	--	--	C
Freckled cardinalfish		*Phaeoptyx conklini*	P	--	--	R	0.33	--	--	O
Remoras	Echeneidae									
Sharksucker		*Echeneis naucrates*	S	--	--	--	--	R	0.33	--
Jacks and Pompanos	Carangidae									
Yellow jack		*Caranx bartholomaei*	S	F	2.30	O	0.83	--	--	O
Blue runner		*Caranx crysos*	S	--	--	R	0.42	O	1.25	--
Bar jack		*Caranx ruber*	P	--	--	O	0.75	O	0.50	--
Permit		*Trachinotus falcatus*	S	A	4.80					
Snappers	Lutjanidae									
Mutton snapper		*Lutjanus analis*	P	--	--	O	0.58	O	0.50	--
Schoolmaster snapper		*Lutjanus apodus*	P	O	0.50	F	1.83	F	2.25	F
Gray snapper		*Lutjanus griseus*	P	--	--	R	0.25			
Lane snapper		*Lutjanus synagris*	P	F	2.50	--	--	--	--	--
Yellowtail snapper		*Ocyurus chrysurus*	P	--	--	F	1.83	C	2.83	--
Mojarras	Gerreidae									
Spotfin mojarra		*Eucinostomus argenteus*	S	C	3.00	O	0.50	--	--	--
Yellowfin mojarra		*Gerres cinereus*	S	--	--	O	0.50	R	0.25	--
Grunts	Pomadasyidae									
Black margate		*Anisotremus surinamensis*	P	--	--	R	0.42	--	--	--
Porkfish		*Anisotremus virginicus*	P	--	--	C	3.17	O	0.58	--
Tomtate		*Haemulon aurolineatum*	P	--	--	A	4.42	C	3.75	A
Caesar grunt		*Haemulon carbonarium*	P	--	--	O	0.58	--	--	--
French grunt		*Haemulon flavolineatum*	P	--	--	F	2.67	C	3.75	C
Cottonwick		*Haemulon melanurum*	P	--	--	R	0.08	--	--	--
Sailors choice		*Haemulon parrai*	P	--	--	O	1.42	R	0.25	--

See footnotes at end of table.

FISHES OF THE HALLANDALE AREA--Continued

Common name	Family	Scientific name	Type of reef species[1]	Abundance[2]						
				Surf zone 1979		First reef 1979		Second reef 1979		Relative abundance[3] 1974
				Relative abundance	Index	Relative abundance	Index	Relative abundance	Index	
White grunt		*Haemulon plumieri*	P	--	--	F	1.92	C	3.33	A
Bluestriped grunt		*Haemulon sciurus*	P	--	--	F	2.58	F	1.83	--
Porgies	Sparidae									
Saucereye porgy		*Calamus calamus*	P	--	--	R	0.25	O	1.42	--
Pinfish		*Lagodon rhomboides*	S	--	--	F	1.75	--	--	--
Drums	Sciaenidae									
High-hat		*Equetus acuminatus*	P	--	--	A	4.42	C	3.08	C
Jackknife fish		*Equetus lanceolatus*	P	--	--	--	--	F	1.83	--
Cubbyu		*Equetus umbrosus*	P	--	--	--	--	O	1.17	--
Reef croaker		*Odontoscion dentex*	P	--	--	O	1.33	--	--	--
Sand drum		*Umbrina coroides*	S	C	3.00	--	--	--	--	--
Goatfishes	Mullidae									
Spotted goatfish		*Pseudupeneus maculatus*	P	--	--	O	0.50	O	0.83	--
Sea chubs	Kyphosidae									
Bermuda chub,		*Kyphosus sectatrix*	P	--	--	R	0.08	--	--	--
Spadefishes	Ephippidae									
Atlantic spadefish		*Chaetodipterus faber*	S	--	--	--	--	--	--	F
Butterflyfishes	Chaetodontidae									
Foureye butterflyfish		*Chaetodon capistratus*	P	--	--	F	1.83	F	1.92	--
Spotfin butterflyfish		*Chaetodon ocellatus*	P	--	--	R	0.33	--	--	F
Reef butterflyfish		*Chaetodon sedentarius*	P	--	--	--	--	C	3.00	--
Banded butterflyfishes		*Chaetodon striatus*	P	--	--	--	--	--	--	O
Blue angelfish		*Holacanthus bermudensis*	P	--	--	C	3.58	C	3.25	--
Queen angelfish		*Holacanthus ciliaris*	P	--	--	O	1.58	F	2.17	F
Rock beauty		*Holacanthus tricolor*	P	--	--	--	--	A	4.42	R
Gray angelfish		*Pomacanthus arcuatus*	P	--	--	R	0.17	A	4.08	F
French angelfish		*Pomacanthus paru*	P	--	--	--	--	F	2.17	F
Damselfishes	Pomacentridae									
Sergeant major		*Abudefduf saxatilis*	P	--	--	F	1.83	O	0.58	--
Blue chromis		*Chromis cyaneus*	P	--	--	--	--	O	0.50	--
Sunshinefish		*Chromis insolatus*	P	--	--	--	--	R	0.33	--
Dusky damselfish		*Pomacentrus fuscus*	P	--	--	F	2.67	O	1.58	--
Beaugregory		*Pomacentrus leucostictus*	P	--	--	O	1.33	C	3.00	--
Bicolor damselfish		*Pomacentrus partitus*	P	--	--	F	2.17	A	4.83	--
Threespot damselfish		*Pomacentrus planifrons*	P	--	--	--	--	C	3.92	--
Cocoa damselfish		*Pomacentrus variabilis*	P	--	--	A	4.08	--	--	--
Wrasses	Labridae									
Spanish hogfish		*Bodianus rufus*	P	--	--	--	--	O	0.75	--
Slippery dick		*Halichoeres bivittatus*	P	--	--	A	4.92	A	4.58	C
Yellowhead wrasse		*Halichoeres garnoti*	P	--	--	--	--	C	3.33	--
Clown wrasse		*Halichoeres maculipinna*	P	--	--	O	0.75	--	--	--

See footnotes at end of table.

FISHES OF THE HALLANDALE AREA--Continued

Common name	Family	Scientific name	Type of reef species[1]	Abundance[2] Surf zone 1979 Relative abundance	Surf zone 1979 Index	First reef 1979 Relative abundance	First reef 1979 Index	Second reef 1979 Relative abundance	Second reef 1979 Index	Relative abundance[3] 1974
Hogfish		*Lachnolaimus maximus*	P	--	--	--	--	O	0.92	R
Bluehead		*Thalassoma bifasciatum*	P	--	--	A	4.25	A	5.00	A
Parrotfishes	Scaridae									
Midnight parrotfish		*Scarus coelestinus*	P	--	--	--	--	O	0.67	--
Blue parrotfish		*Scarus coeruleus*	P	--	--	--	--	R	0.42	--
Striped parrotfish		*Scarus croicensis*	P	--	--	F	1.83	A	4.42	F
Princess parrotfish		*Scarus taeniopterus*	P	--	--	--	--	C	3.33	R
Queen parrotfish		*Scarus vetula*	P	--	--	--	--	O	0.58	--
Redband parrotfish		*Sparisoma aurofrenatum*	P	--	--	--	--	O	1.50	--
Redtail parrotfish		*Sparisoma chrysopterum*	P	--	--	A	4.58	O	1.58	F
Bucktooth parrotfish		*Sparisoma radians*	P	--	--	O	1.42	--	--	--
Redfin parrotfish		*Sparisoma rubripinne*	P	O	0.50	O	1.17	O	0.58	F
Stoplight parrotfish		*Sparisoma viride*	P	--	--	F	1.92	C	3.17	--
Barracudas	Sphyraenidae									
Great barracuda		*Sphyraena barracuda*	P	--	--	R	0.08	--	--	--
Jawfishes	Opistognathidae									
Yellowhead jawfish		*Opistognathus aurifrons*	P	--	--.	--	--	R	0.17	--
Dusky jawfish		*Opistognathus whitehursti*	S	--	--	--	--	--	--	C
Clinids	Clinidae									
Roughhead blenny		*Acanthemblemaria aspera*	P	--	--	--	--	--	--	F
Sailfin blenny		*Emblemaria pandionis*	P	--	--	--	--	R	0.08	--
Downy blenny		*Labrisomus kalisherae*	P	--	--	O	0.75	--	--	--
Rosy blenny		*Malacoctenus macropus*	P	--	--	--	--	--	--	C
Saddled blenny		*Malacoctenus triangulatus*	P	--	--	R	0.33	R	0.08	--
Combtooth blennies	Blenniidae									
Seaweed blenny		*Blennius marmoreus*	P	--	--	R	0.33	O	0.75	C
Redlip blenny		*Ophioblennius atlanticus*	P	--	--	--	--	O	0.58	--
Gobies	Gobiidae									
Bridled goby		*Coryphopterus glaucofraenum*	S	--	--	C	2.92	A	4.33	--
Masked goby		*Coryphopterus personatus*	P	--	--	--	--	C	3.58	--
Tiger goby		*Gobiosoma macrodon*	P	--	--	O	1.42	--	--	--
Neon goby		*Gobiosoma oceanops*	P	--	--.	F	2.33	C	3.83	C
Blue goby		*Ioglossus calliurus*	P	--	--	--	--	F	2.50	--
Surgeonfishes	Acanthuridae									
Doctorfish		*Acanthurus chirurgus*	P	--	--	A	4.17	A	4.83	F
Blue tang		*Acanthurus coeruleus*	P	--	--	O	1.42	F	2.50	O

See footnotes at end of table.

FISHES OF THE HALLANDALE AREA--Continued

Common name	Family	Scientific name	Type of reef species[1]	Abundance[2]						
				Surf zone 1979		First reef 1979		Second reef 1979		Relative abundance[3] 1974
				Relative abundance	Index	Relative abundance	Index	Relative abundance	Index	
Mackerels and Tunas	**Scombridae**									
Cero		*Scomberomorus regalis*	S	--	--	--	--	O	0.50	--
Scorpionfishes	**Scorpaenidae**									
Spotted scorpionfish		*Scorpaena plumieri*	P	--	--	--	--	--	--	R
Triggerfishes and Filefishes	**Balistidae**									
Gray triggerfish		*Balistes capriscus*	S	--	--	F	2.33	R	0.33	--
Queen triggerfish		*Balistes vetula*	P	--	--	R	0.33	R	0.25	--
Whitespotted filefish		*Cantherhines macrocerus*	P	--	--	--	--	R	0.17	--
Orangespotted filefish		*Cantherhines pullus*	P	--	--	--	--	O	1.42	--
Ocean triggerfish		*Canthidermis sufflamen*	S	--	--	O	0.92	O	0.67	C
Planehead filefish		*Monacanthus hispidus*	S	--	--	--	--	O	1.17	--
Boxfishes	**Ostraciidae**									
Smooth trunkfish		*Lactophrys triqueter*	P	--	--	--	--	R	0.42	--
Puffers	**Tetraodontidae**									
Sharpnose puffer		*Canthigaster rostrata*	P	--	--	O	1.42	C	3.67	--
Bandtail puffer		*Sphoeroides spengleri*	S	--	--	R	0.42	R	0.42	O
Porcupinefishes	**Diodontidae**									
Balloonfish		*Diodon holacanthus*	P	--	--	F	2.33	O	0.92	O

[1]Type of reef species: P = Primary, S = Secondary.

[2]Abundance: A = Abundant, C = Common, F = Frequent, O = Occasional, R = Rare.

[3]First and second reefs combined.

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